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IMPLEMENTATION OF THE USAF STANDARD BASE SUPPLY SYSTEM: A QUANTITATIVE STUDY

K. E. Codlin, W. H. McGlothlin, A. H. Schainblatt, and R. L. Van Horn

PREPARED FOR:
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PREFACE

In August 1965, the U.S. Air Force embarked on a significant new program. During the following year, 110 Air Force bases were converted to the USAF Standard Base Level Supply System operating on UNIVAC 1050-II Electronic Data-Processing Systems. This activity represents the first Air-Force-wide implementation of a centrally designed, computer-based logistics support system.

Increasing use of computers for logistic support and other management and operating functions is a clear trend in the Air Force and many other large organizations. The Base Supply System is therefore important both in its own right and as a prototype of many future Air Force activities. Maintenance, personnel, and other functional areas are developing and have partially implemented standard systems of their own.

This study describes a quantitative analysis of the installation and subsequent operation of the Standard Base Level Supply System. The study is quantitative in the sense that it is based largely on specific empirical data and uses statistical techniques to analyze the data. It uses data from the large group of bases involved in the program to help identify factors that influenced the implementation process.

Mr. Van Horn is a professor at Carnegie-Mellon University and a consultant to The RAND Corporation.

SUMMARY

This study analyzes data obtained from the recent conversion of Air Force bases to the Standard Base-Level Supply System, in an effort to identify variables affecting the implementation and subsequent operation of automated data systems. The major sample consists of 69 bases from ADC, ATC, SAC, and TAC, with some additional data from a larger sample of 103 bases. The data categories are defined as follows: (1) performance variables consist of measures of the efficiency with which the conversion was accomplished, the accuracy of the postconversion operation, and the effectiveness of the supply system; (2) base characteristics include preconversion levels of automation, and account size and workload; (3) base personnel proficiency consists of rankings on such variables as training, EDP experience, and management discipline.

The statistical analysis consists primarily of correlating variables in the above data categories. When base characteristics were significantly related to performance variables, the former were statistically controlled in the examination of personnel proficiency effects. The results indicate that the conversion time required is primarily affected by the base's account size and its position in the conversion schedule. Within the range of personnel proficiency and record preparation observed, these variables do not act as limiting factors in determining the conversion time. The postconversion measures of performance correlate significantly with personnel proficiency variables; those showing the strongest relationships are ratings of training, management discipline, morale, and preconversion file preparation. Postconversion measures of the computer input error rate (error reject rate) and record inconsistency rate (conversion reject rate) are also positively correlated with account activity.

The data and the analysis suggest that conversion time and error rates for a program similar to the Base Supply System are not as critical as anticipated. In all cases, the initial conversion times were easily tolerated and learning appears to have progressed rapidly. SAC, with minimum training, incurred higher error rates but not measurable degradation of fill rates when compared with other commands. This study leads toward two interesting areas for further inquiry.

First, fill-rate appeared insensitive to changes in the supply management system, yet it is a primary Air Force measure of performance. Perhaps a better measure is needed or, more significantly, perhaps the roles, functions, and contributions of the supply management system deserve careful consideration.

Second, implementation as defined and studied here captures only a small part of the broad automated system design and development problem. It is to be hoped that the idea of applying quantitative analysis to the problem can be extended into more difficult but potentially more significant areas. If this study contributes in any way to such an extension, it has served its purpose.

ACKNOWLEDGMENTS

The authors wish to thank the many people in the Air Force who provided data for this study. The Supply Systems Design Office at Hq USAF arranged for us to receive the RCS:AF-E61 forms describing the conversion actions, and also provided the postconversion reject data and monthly equipment-supply reports. The conversion team members from the Hqs of ADC, ATC, SAC, and TAC supplied the ranking data for the personnel proficiency measures, and also provided other useful information on the individual conversions. In addition, personnel at Hq ADC provided a functional classification of the reject phases.

The authors also thank Craig Sherbrooke and Bennett Fox of RAND for their many helpful comments and suggestions.

CONTENTS

I. INTRODUCTION

The installation of the Standard Base-Level Supply System throughout the Air Force provided an interesting opportunity to apply quantitative methods in the study of the implementation and operation of automated systems. During the period of this study, August 1965 to August 1966, 110 bases were converted to the Standard System, with identical computers (UNIVAC 1050-II), programs, and external procedures. Since the Air Force generated data on a number of measures related to implementation, this large sample of bases enabled the use o[illegible]tistical analysis to examine factors that appeared important.

THE STANDARD SYSTEM

The Air Force approved the concept of a standard supply system in 1962 and selected the UNIVAC 1050-II computer in November 1963. The system was to provide standardized computers, programs, and external procedures for base supply operations throughout the Air Force. It also incorporated equipment and accounting-finance sections, and used about ten remote inputs located at various points on the base. The major advantages expected by the Air Force from this approach were (1) better interaction among AFLC depots and the various commands; (2) increased ability to implement Air Force policy changes at base level; (3) uniform measures of base-level performance and the ability to assess the impact of policy changes; (4) the establishment of a uniform training program to allow intercommand transfers without retraining; and (5) elimination of duplicate programming efforts in the various commands.

A Supply Systems Design Office (SSDO), composed of headquarters and command personnel and located at Bolling AFB, undertook the design and programming. The base implementation program was initially scheduled for September 1964, but the allotment of time proved insufficient, partly because additional functions--equipment and accounting-finance--were subsequently included. The conversion program of approximately ten bases a month began in September 1965.

The concept called for delivering a complete program package from SSDO to the base. SSDO personnel supplied some preliminary on-base aid and maintained a telephone trouble-shooting center throughout the conversion. The primary responsibility for the conversion resided with the commands, however. The larger commands provided mobile conversion teams of 4 to 7 persons, who directed the implementation to the new system. They normally joined the base effort shortly before the time the base assumed post-post operation and remained until pre-post operation was resumed. Preparation for conversion began six months prior to the scheduled date with the building of physical facilities (where required). Other major preconversion steps included the preparation and error-checking of item records and the reconciliation of supply and accounting-finance records.

Prior to the introduction of the Standard System, bases operated under a variety of computer and punch-card procedures; thus, the previous base experience with electronic data processing equipment varied widely among commands. The approaches to training and other preparation also differed from one command to another; and, of course, the background of base personnel varied within commands. Training included formal courses for key personnel by the Air Training Command at Amarillo; the individual commands were responsible for base-level training. The differences in their approaches are discussed in Sec. IV. Another factor that differed between commands, and also within commands, was the availability and utilization of the 1050 computer prior to the conversion date. Some bases had the capability for dual operation of both the old and new computers, while others did not. When available, the 1050 was used in various degrees for practice and, in some cases, for mock conversions to prepare item files.

APPROACH OF THE STUDY

The present study seeks to determine, through statistical analysis, the factors influencing conversion and subsequent operation under the new system. The approach involves measurement of base performance during conversion and afterwards; and an analysis of interbase differences in terms of previous experience, management proficiency,

preparation and training, mission difficulty, and other relevant variables. The major goal is to understand how these factors affected conversion to the Standard Supply System and, if possible, how planners of future automated systems can profit from this experience. A secondary goal is to examine various measures of ongoing base supply performance; the degree of communality between such indicators; and the extent to which they measure management proficiency as opposed to inherent inter-base differences in mission difficulty.

The study does not attempt a comprehensive analysis of the design, development, and operating effectiveness of the Standard System. It neither examines the development of the programs and procedures, nor attempts to compare new systems with previous ones. It also excludes any evaluation of advantages versus disadvantages of the centralized approach, and of whether it is possible to enforce continuing standardization. While these are valid areas of inquiry, they appear more suitable to an intensive case study technique. The authors feel that the availability of data from a large number of cases can be best utilized to establish significant relationships among base performance measures and the relevant explanatory variables.

STUDY PROCEDURES

Two major techniques are available to perform quantitative studies of functioning organizations. One, generally called a field test, introduces specific procedural changes (independent variables) and measures the resulting difference in performance measures (dependent variables). This method is analogous to a laboratory experiment in which the independent variable is manipulated, its effect on the dependent variable measured, and the other relevant variables are held as constant as possible. This method is infeasible in many situations, either because the variables of interest cannot be readily manipulated, or, more frequently, because the overwhelming objective--to accomplish the operation--cannot be compromised for the sake of studying the process.

In the second method of studying organizations, the investigator gathers data on many ongoing (uncontrolled) cases and attempts to relate performance differences to various explanatory variables. This method

is highly inefficient compared with the first, since large amounts of data are needed to isolate the effects of a specific explanatory variable from those of the relatively large number of other uncontrolled explanatory variables; however, it is often the only practical alternative.

This study utilizes the second method to examine the factors affecting the introduction of the Standard System into a large number of ongoing organizations. Figure 1 outlines the performance measures and explanatory variables in the current investigation. The performance measures are associated with three periods: (1) the year prior to the introduction of the Standard System; (2) the period of actual conversion; and (3) the postconversion period, consisting of the base conversion date to August 1966.

Command and base differences in performance measures are then assumed to be a function of two basic types of explanatory variables: (1) personnel characteristics and (2) base characteristics. The former are further divided into more general factors such as management discipline, morale, etc., and those more specifically related to the conversion, such as file preparation and training of base personnel in the Standard System procedures. Similarly, base characteristics include a set of general factors such as account size and number of weapons supported, which are expected to affect performance measures, and those more specifically related to the conversion: previous level of automation and position in the conversion schedule.

The data used in this study came from a set of 103 bases distributed among commands or groups of commands in the following way:

Command Grouping	No. of Bases in Study
ADC	14
ATC	14
SAC	27
TAC	14
PACAF, AAF	7
USAFE	11
MATS, AFSC, AFLC, AU	16
Total	103

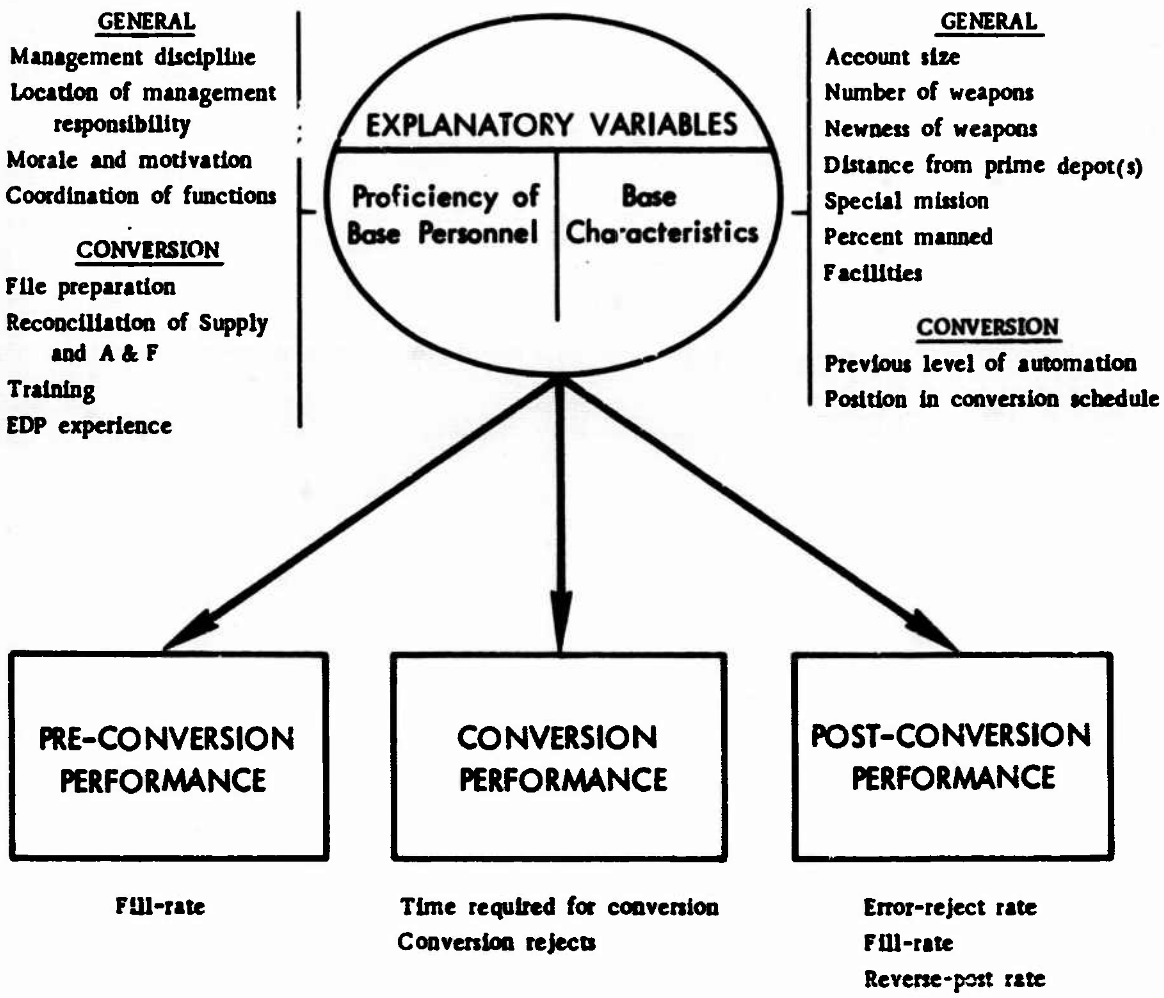

Fig 1 -- Outline of performance and explanatory variables

The following two sections define the performance measures and explanatory variables in more detail, including the procedures used in the data collection.

PERFORMANCE MEASURES

Preconversion performance measures were available for ADC, ATC, SAC, and TAC bases from the periodic supply summary publications that these commands issue.* These reports contain a number of measures of supply performance, but the measures are not uniform among commands. The only indicator available for all four commands is the percentage of item requests filled, i.e., fill-rate or supply effectiveness. The method of computing this statistic also varies somewhat among commands; however, it may be used as an indication of base performance within a command. The preconversion measure used in this study is the mean base fill-rate for the approximate period of August 1964 to July 1965.

Conversion performance measures consist of the time required to accomplish the conversion and the number of conversion rejects--incorrect 1050 inputs--as obtained from the special conversion progress report, RCS:AF-E61. Base conversion times are weighted to reduce differences due to account size, and adjusted for computer downtime. Conversion rejects are expressed as a rate per 100 items loaded.

Postconversion measures consist of the mean base rejects per 100 inputs, the line-item support effectiveness (fill-rate), and the reverse-post transactions per 100 inputs. The reject rate was obtained from a special monthly listing that SSDO provided, and the corresponding number of inputs was obtained from the monthly equipment-supply report. Several other statistics appearing in the latter report were considered for performance measures (inventory adjustments, items without warehouse locations, items-past-due inventory, and inventory accuracy); however, these measures generally lacked the month-to-month stability necessary for the present analysis. Postconversion performance measures were

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*ADC: PROBE, ADCRP 67-1, quarterly
ATC: FACTS, semiannually
SAC: Consolidated Supply Reports Summary, monthly; became "Supply Trends" after conversion
TAC: DEMAND, TACRP 67-1, monthly.

considered partly to indicate the adequacy of base conversion actions and prior preparation. This was particularly true of the reject rate, which was adjusted for management-type rejects and then listed by base function. The treatment of this variable is described more fully in Sec. II.

EXPLANATORY VARIABLES

The explanatory variables are of two types: objective and subjective. The objective variables were obtained directly from the conversion progress reports and include account size; actual/authorized manning; previous level of automation; computer time available prior to conversion; and position in conversion schedule. The subjective variables were obtained in the form of rankings made by conversion team members for ADC, ATC, SAC, and TAC, and were collected via personal interviews.

Subjective Variables

Team members were asked to consider the bases where they participated in the conversion, and rank them separately on each of eleven variables. Each team typically aided in the conversion of five to eight bases, and members had two to four weeks of work-interaction with each base. No team visited all bases. They were told that the rankings were for a statistical study and would be maintained in confidence. They were asked to make their rankings without consulting other team members, and to attempt to rank the bases independently on each variable without allowing their overall impressions of "good" and "poor" bases to influence their specific rankings. The team members had no knowledge of the error reject rate or the postconversion reject rate experienced at any base. They did know the conversion time for the bases they had implemented. The variables used for the ranking were the following:

1. Preconversion file preparation
2. Reconciliation of supply and accounting-finance records
3. Training
4. EDP experience
5. Morale and motivation

6. Location of management responsibility
7. Management discipline
8. Coordination among relevant groups
9. Facilities
10. Desirability of location
11. Mission difficulty

The raw rankings were not used directly but were modified in various ways to arrive at the final base ranking within each command. At ADC, three officers maintained close surveillance over the entire conversion, and the average of their independent rankings was used as the final ranking. At ATC, members of the two conversion teams made independent rankings, and the two team chiefs then arrived at a single commandwide ranking with the aid of data from team members. TAC obtained the final ranking from the average of independent overall rankings submitted by three officers. At SAC, the conversion was conducted more or less independently by four teams (Headquarters, plus the 2d, 8th, and 15th Air Forces). It was impossible to obtain a commandwide ranking from personnel familiar with all SAC bases. The team members from the 8th Air Force were not available for interviews; rankings for the other three groups were averages of team-member rankings. The rankings for the three groups were placed on a common scale, and a single commandwide ranking was obtained from the relative position on this scale. It is desirable to have a measure of inter-rater reliability; however, the variability in the manner of obtaining the rankings, and the fact that final rankings were made with the aid of subsample rankings from the conversion teams, prevented the computation of correlations among raters.

Objective Variables

Intercommand differences are most relevant to the conversion and subsequent operation. They consist primarily of the preconversion level of automation, and the preparation and training approaches employed. Of the four commands for which conversion team-rating data were available (ADC, ATC, SAC, and TAC), three utilized computers prior to the standard system, and the fourth (ATC) had a split operation with four computer and ten PCAM bases.

While the standard system specified loading procedures for the 1050 computer, the individual commands primarily determined methods of preparing the files and training base personnel. Formal courses for key personnel were given at the Amarillo Technical Training Center and instructional material (AFM 67-6) was provided, but the commands differed considerably in their approaches.

ADC's approach emphasized preconversion file preparation. All bases had the capability for dual operation of the 305 and 1050, and the 1050 was installed approximately six weeks before the actual conversion began. ADC provided a three-man team, which visited the bases some 30 days prior to conversion and conducted a full-scale download of the 305 and upload of the 1050, requiring 10 to 15 days. The mock conversion provided some training for 1050 console operators and some handling of computer rejects; however, the major purpose was to correct file discrepancies and omissions.

In general, Hq ADC assumed no active role in training base-level personnel. The 1050 was available for training purposes as well as for the mock conversion, and a file dump from a previously converted base was available for practice. The conversion team typically arrived one day prior to conversion and left immediately after the resumption of pre-post operation.

SAC also adopted a policy of delegating training responsibilities to the base level. Their four conversion teams operated independently and their procedures varied. Of the four major commands, SAC bases probably received the least command direction of training and preparation. In contrast to ADC, about one-half of the SAC bases did not install the 1050 before conversion started, and only about one-fourth had it available for more than two weeks. SAC bases depended primarily on the edit procedures contained in the 1050 upload sequence for detecting record inconsistencies. A few bases performed a mock load and, where the capability existed, used a file dump from a previously converted base for preconversion practice. Virtually all SAC bases sent 4 to 6 key personnel to participate in a prior conversion, and SAC conversion teams generally emphasized this as a major source of training. In addition, Hq SAC provided a one-week management course for 4 to 8 base personnel as a supplement to the Amarillo training.

ATC and TAC Hqs were considerably more active in base-level training. ATC provided a 4-man team to give a one-week orientation course six months prior to conversion, another one-week visit at the three-month point for checking on base progress, one conversion team member at the one-month point, and the remainder of the team one week prior to conversion. In addition, one team member stayed one week after the base resumed pre-post operation. With four exceptions, the ATC bases installed the 1050 two or more weeks before conversion and used a previously converted base file for practice. Four bases performed a mock load. ATC bases sent 5 to 10 persons to a prior-conversion base for two or three days. As mentioned above, ATC bases differed from ADC, SAC, and TAC in terms of prior experience with computer systems. The large majority of ATC console operators had no EDP experience before their selection for training in the 1050 operation.

TAC Hq also provided bases with a three- or four-day orientation visit; another visit at the two-month period; and a 30-hour training course for all base personnel. The conversion team arrived at the base one week prior to the conversion. About three-fourths of TAC bases installed the 1050 in time to get two to three weeks practice using the file of a previously converted base. No mock load was employed for the 305 other than a brief "dummy load" during the download period. Most bases had access to a 1401 computer that was used for editing file records.

In summary, ADC bases had the earliest prior installation of the 1050 and accomplished a full-scale mock conversion before the actual base conversion; ATC and TAC Hqs personnel participated more actively in the base-level training than did the other commands, and SAC bases had the least preconversion training on the 1050. Information was not obtained on the training procedures of the other commands.

STUDY CONTENTS

Illustrations of data used in this st , appear in the Appendix. Section II of this Memorandum contains an analysis of the data, and Sec. III suggests some interpretations or the results of analysis.

II. ANALYSIS

This section applies two forms of analysis. First, selected portions of the data are organized into tables, such simple statistics as means and ranges are computed, and absolute magnitudes of various parameters are examined. The second form of analysis is the application of multivariate regression to study the statistical relationships among the variables.

CONVERSION TIME

During the conversion period, Base Supply continued on a post-post operation, i.e., requisitions were filled on arrival and then stored for subsequent posting. Adjusting the computer records to reflect these changes was the final step in the conversion process. Customers were asked to anticipate requirements and requisition before conversion began. If posting had to be deferred for a prolonged period, the quality of the service might have dropped seriously. For this reason, the time required for conversion was of crucial concern, and the task proceeded on a 24-hour basis until completed.

For bases already using a computer system (ADC, SAC, and TAC), conversion is divided into five major steps:

1. Clear documents in the system at the time the post-post mode begins
2. Download records from the previous computer
3. Upload records on the 1050 computer
4. Do postconversion load actions
5. Process post-post backlog.

Table 1 shows the average time required to complete the conversion steps, with no adjustment for account size, computer downtime, or position in the conversion schedule. ADC, SAC, and TAC were fully computerized; the other commands contained both computer and PCAM bases. Since PCAM bases did not require a download period, the average times required to accomplish only the last three steps are shown for PCAM bases in Table 1.

Table 1

MEAN NUMBER OF DAYS REQUIRED FOR CONVERSION, BY COMMAND

Item	Prior Computer				Prior Punched Card					Overall Average
	TAC	ADC	SAC	Average	ATC	USAFE	PCAF, AAF	MATS, AFSC, AFLC, AU	Average	
Command characteristics										
Number of bases	14	27	14		14	7	11	16		
Mean file size[a]	142	143	153	145	126	148	159	197	157	150
Total conversion time										
Range	8-24	8-45	10-30		7-39	9-44	18-33	6-45		
Average	15.3	21.8	18.7	19.4	12.7	20.3	18.6	17.7	16.5	18.0
Active 1050 conversion										
Upload of 1050	3.3	5.7	4.9	4.9	5.7	8.1	9.9	7.2	7.4	6.0
Postconversion actions	2.2	3.8	2.7	3.1	3.9	5.4	4.4	3.6	4.0	3.6
Process post-post backlog	3.9	5.5	3.8	4.7	3.1	6.8	4.3	6.9	5.1	4.9
Total	9.4	15.0	11.4	12.7	12.7	20.3	18.6	17.7	16.5	14.5
Preparation										
Document clearance	1.3	4.8	4.0	3.7						
Download of prior computer	4.6	2.0	3.3	3.0						
Total	5.9	6.8	7.3	6.7						

[a]In thousands of records.

The raw data in Table 1 contain a number of elements that may obscure the true relationships. For example, time lost due to computer unavailability may extend conversion time independently of other factors--and computer downtime did vary widely (from 0 to 8 days) for bases included in this study. In all subsequent analysis in this Memorandum, downtime is assumed to cause a direct increase in conversion time, and is therefore subtracted from the observed conversion time.

Second, it is reasonable to suspect that conversion time will decrease as a function of position in the conversion schedule and will be less for bases that previously had computers. These statements hypothesize that learning has occurred in two ways: conversion teams learn as they go, and later bases are consequently converted faster than earlier bases; and since base personnel also learn, computer bases can convert faster than former PCAM bases. Finally, conversion time appears to depend to some extent on account size: bases with larger accounts take longer to convert.

We can try to confirm or deny the existence of those effects by looking at the data in Table 1, but the problem is difficult. For this reason, the next section discusses a comprehensive mathematical analysis of relationships between variables and measures.

POSTCONVERSION

After completing the 1050 loading, and processing the accumulated transactions, the conversion team departed and the base personnel resumed a normal pre-post operation with the new system. The adequacy with which this was accomplished may be measured by several variables: error-reject, reverse-post, and fill-rates.

Error-Reject Rate

Probably the most direct measure is the error-reject rate for the computer inputs. The computer is programmed to detect and reject some 850 types of inconsistencies. Some of these do not indicate personnel errors; they are designed as a manner of quickly conveying relevant

information on the account status e.g., the requested item is not stocked. Other rejects indicate a wide variety of omissions and inconsistencies resulting from errors on the part of the input initiator, or lack of compatibility within the files. Table 2 lists the twenty most recurrent rejects in order of Air-Force-wide frequency, based on available data from the time of conversion to August 1966. These twenty rejects account for almost 70 percent of the total and demonstrate a high degree of consistency among commands. The Air-Force-wide ratio of rejects to inputs is 13.5 percent. The Supply Systems Design Office classifies rejects as either "management-type" (resulting from planned or known characteristics of the system) or "errors" (resulting from mistakes by base personnel). Using this classification, the Air-Force-wide error-reject rate is 6.7 percent. All statistics dealing with rejects in the remainder of this Memorandum refer to the error-reject rate.

Figure 2 shows the mean monthly base error-reject rate as a function of months following conversion for ADC, ATC, SAC, and TAC. The monthly base samples are not constant, because of missing data and the fact that only those bases converted before January 1966 had completed eight months of operations when these data were collected. In particular, the SAC rates for months 6, 7, and 8 are based on very incomplete data. Nevertheless, these results are surprising. The error-reject rate during month 1 is, at worst, only 50 percent higher than for months 5 through 8; and the rates for months 2, 3, and 4 resemble those for months 6 through 8. In short, after the first month, error-reject rates show no clear trend.

One might expect error-reject rates to start high and trend slowly downward. Many explanations are possible. The data may be bad; the error-checks in the program may not detect many serious problems; or the system is simple enough and instructions clear enough that personnel master it within a month. In any event, the observed behavior appears to warrant some further thought.

Table 2

POSTCONVERSION REJECTS

(In %)

Reject Number	Description[a]	ADC	ATC	SAC	TAC	USAFE	PACAF & AAF	Other	AF-wide
295	Rec. not loaded	18.1	17.6	17.0	20.2	18.8	18.9	16.4	18.0
704	S/N not on file	9.1	7.6	5.1	8.4	7.4	4.7	5.2	6.8
115*	S/N not located	6.7	6.6	5.8	5.0	7.0	4.7	7.0	6.1
329*	Unit error	4.0	3.8	4.0	4.2	4.9	4.8	4.0	4.2
262*	Detail not loaded	2.8	3.4	4.4	3.0	3.0	3.8	4.3	3.6
263*	Detail not loaded	2.9	3.1	4.4	3.1	3.2	4.2	3.7	3.6
296	S/N frozen	1.9	1.9	5.7	2.0	3.0	3.7	4.8	3.5
706	D/N not on file	3.9	4.2	2.6	4.2	4.3	2.2	2.5	3.4
260*	Detail not loaded	2.7	3.2	4.0	2.5	2.4	6.0	3.0	3.3
708	Invalid code	3.1	2.7	2.4	2.4	3.8	1.6	2.9	2.7
289	Exception code	2.2	2.7	2.9	3.7	1.7	4.1	2.0	2.7
705	Code omitted	3.3	2.7	1.4	2.5	1.5	0.5	2.1	2.1
290*	Quantity error	1.2	1.4	3.0	1.3	1.7	2.0	2.1	1.9
367*	Code unauthorized	1.5	1.9	1.5	1.7	2.0	3.1	1.4	1.8
113*	Duplicate	1.4	0.8	0.6	0.8	1.6	1.3	2.2	1.2
275	Funds unavailable	1.0	1.0	0.8	0.8	0.9	0.9	1.6	1.0
265*	Duplicate	0.8	0.9	0.8	0.8	1.0	0.9	0.8	0.8
432	No cancellation	0.8	1.1	0.9	0.9	0.7	0.8	0.6	0.8
261*	D/N error	0.6	0.9	1.0	0.7	0.8	0.8	0.8	0.8
346*	Duplicate	0.5	0.7	1.0	0.6	0.9	1.0	0.8	0.8
Other		31.5	31.8	30.7	31.2	29.4	30.0	31.8	30.9
Postconversion Rejects as a Percentage of Input Actions									
Management rejects		7.8	6.0	7.2	6.6	6.1	6.9	6.4	6.8
Error rejects		6.5	5.6	7.8	6.0	7.3	7.0	6.7	6.7
Total		14.3	11.6	15.0	12.6	13.4	14.1	13.1	13.5

NOTE: Starred items are error rejects.

[a]For a more complete description of rejects, see AFM 67-1, Vol. II, Part 2, Chap. 30.

Number of bases reporting

ADC	7	9	10	11	12	10	9	8
ATC	11	12	11	11	11	9	5	6
SAC	12	17	14	16	14	9	7	4
TAC	10	9	12	13	10	9	7	6

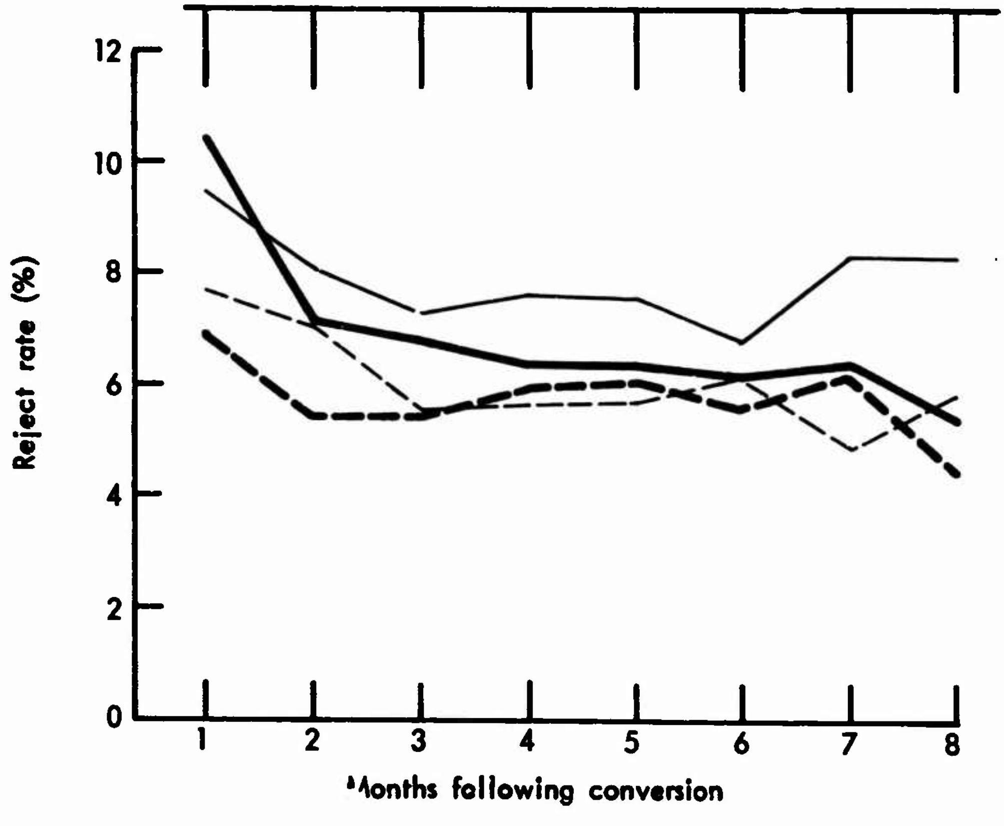

Fig. 2 -- Mean postconversion reject rate as a function of number of months following conversion

Postconversion Reverse-Post Rate

Reverse-post transactions are initiated to correct inconsistencies between computer records and physical assets, and various other documentation errors, and thus provide another measure of record accuracy. For ADC, SAC, and TAC, the mean monthly base reverse-post rate as a function of months following conversion appears in the Appendix. ATC did not utilize the reverse-post procedures of the standard program, so no data were available. As for error-reject rates, the data are incomplete and the number of bases in each monthly sample vary.

For TAC and ADC the rates start near zero, rise to about 0.5 percent, and then appear to decline slowly toward 0.2 percent or lower. For SAC the rate climbs steadily to over 0.6 percent by month 8; but of the 27 SAC bases, the number reporting has declined to 4 by that time. Once again, no clear pattern is evident.

Postconversion Item Fill-Rate

The final measure of performance is the item fill-rate--the percentage of item requests satisfied. This is the commonest measure of base supply performance and is closely related to mission, whereas the reject and reverse-post rates are more related to adherence to prescribed procedures.

Since fill-rate is a complex function of many factors, we should expect little immediate effect from conversion. The data in the Appendix tend to confirm this view. We can note one interesting change.

Apparently, the new system is causing some instability in fill-rates (and presumably supply performance). The month-to-month variability is fairly high compared with behavior before conversion.

RELATION BETWEEN PERFORMANCE VARIABLES AND BASE CHARACTERISTICS

This section applies multiple correlation analysis to examine the relation between performance variables and base characteristics.

For the reader who is unfamiliar with statistical terminology, the correlation coefficient is an index of agreement between two variables and may range from -1.0 to 1.0. Positive correlations imply that the

variables tend to vary in the same direction, i.e., when one is high the other tends to be high. Negative correlations indicate an inverse relation--when one variable is high the other tends to be low. The size of the absolute value of the correlation (in either direction) indicates the extent of the relationship.

Another concept used in Tables 3 through 8 is statistical significance. In these tables, correlation coefficients are large enough so that the odds of their appearance due to chance alone are less than 1 in 20 (as denoted by *), and less than 1 in 100 (as denoted by **). The statistical significance of a correlation coefficient is determined both by the size of the coefficient and the size of the sample, In general, the sample sizes for the commands are too low to yield significant coefficients, and the significance level will be denoted only for the total sample. The sample sizes in Tables 3 through 8 are approximate; where data are missing or deleted, the sample size for the correlation is correspondingly reduced.

Performance Variables

The performance variables discussed in this analysis are as follows:

1. Conversion time -- Total time base was in a post-post mode of operation, after deleting computer downtime and weighting for number of records loaded; for ATC, conversion time is for steps 3, 4, and 5.
2. Conversion reject rate -- Number of rejects recorded by base during the 1050 upload, divided by the number of records loaded; does not include the postconversion load rejects.
3. Postconversion reject rate -- Base error-rejects from the beginning of the third month after conversion until August 1966, divided by the total inputs over the same period.
4. Postconversion reverse-post rate -- Base reverse-post transactions for months 3 through 5 following conversion, divided by the total inputs for the same period.
5. Item fill-rate -- Base average monthly item fill-rate for months 2 through 5 following conversion (monthly base supply report).

Base Characteristics

The base characteristics used in the analysis are as follows:

1. Mission difficulty -- Ranking of overall difficulty of

achieving high performance scores due to factors other than proficiency of base personnel; obtained from conversion teams or other command headquarters personnel.

2. Items stocked -- Average number of item records reported in monthly base supply report for months 2 through 5 following conversion.

3. Average monthly inputs -- Average total inputs obtained from the monthly base equipment supply report for months 2 through 5 following conversion.

4. Position in conversion schedule -- Approximate order of conversion by the individual teams.

Data Limitations

As mentioned earlier, no reverse-post data were available for ATC. In addition, the fill-rate data for the two types of ATC bases (Technical Training Centers and Flying Training Wings) were considered too heterogeneous for use in the analysis, and data on fill-rate for the five TTC bases were deleted. Similarly, fill-rate data for four SAC missile bases were excluded.*

Correlation Results

Table 3 presents the correlations between the four base characteristics and the five performance variables listed above. Data are given for the command samples, and the final column shows the weighted average correlation of the command samples.**

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*Richards-Gebaur was excluded from the ADC sample because it was the lead base for all commands and was considered atypical. Conversion time and conversion rejects were excluded for Webb in the ATC sample because the account was loaded at another base. The conversion reject rate at Laughlin (ATC) was excessively high and was therefore excluded. Conversion team data were not obtained for most of the Eighth Air Force SAC bases, and they are excluded.

**A weighted average correlation is found by converting the correlation coefficients to be averaged into Fisher z scores. Then the z scores can be averaged with weightings based upon relative sample sizes. Once a weighted average Fisher z score is found, it can be converted back to a correlation coefficient. This procedure is outlined in J. P. Guilford, Fundamental Statistics in Psychology and Education, McGraw-Hill Book Company, New York, 1956, pp. 325-326.

Table 3

CORRELATION BETWEEN BASE CHARACTERISTICS AND PERFORMANCE VARIABLES

Variable	ADC N=14	ATC N=14	SAC N=19	TAC N=14	Total N=61
Position in conversion schedule vs.:					
Conversion time (adj)	-0.85	-0.22	-0.47	-0.56	-0.58**
Conversion reject rate	-0.27	-0.02	-0.48	-0.61	-0.38**
Postconversion reject rate	-0.16	0.34	0.26	0.29	0.19
Postconversion reverse-post rate	0.20	--	-0.24	0.29	0.07
Postconversion fill-rate	0.15	-0.65	0.25	-0.10	0.00
Mission difficulty vs.:					
Conversion time (adj)	0.16	0.02	0.12	0.24	0.14
Conversion reject rate	0.11	0.30	0.37	0.15	0.24
Postconversion reject rate	0.54	0.59	0.29	0.31	0.43**
Postconversion reverse-post rate	0.48	--	0.27	-0.28	0.18
Postconversion fill-rate	0.15	-0.24	0.21	0.10	0.11
Items stocked vs.:					
Conversion time (adj)	0.30	-0.01	-0.01	-0.16	0.04
Conversion reject rate	0.02	0.57	0.33	0.14	0.27
Postconversion reject rate	0.52	0.82	0.31	-0.05	0.45**
Postconversion reverse-post rate	0.54	--	0.46	0.22	0.41**
Postconversion fill-rate	0.30	-0.34	0.21	-0.12	0.08
Average monthly inputs vs.:					
Conversion reject rate	0.13	0.72	0.50	0.26	0.43**
Postconversion reject rate	0.35	0.74	0.26	0.07	0.37**
Postconversion reverse-post rate	0.45	--	0.14	0.15	0.25
Postconversion fill-rate	0.33	-0.34	-0.16	-0.22	-0.06

NOTE: ** = significant at the 0.01 confidence level.

Mission difficulty, items stocked, and monthly inputs are all positively correlated with postconversion reject rate and, to a lesser extent, with reverse-post rate; i.e., error rates tend to be higher for large bases. Account size and activity are more strongly related to reject rate and reverse-post rate at ADC and ATC than at SAC and TAC. This occurs partly because base size varies more widely at ADC and ATC (see Appendix).

With the exception of conversion time, the performance variables are all ratios whose denominators are measures of base account size or activity. When these ratios are correlated with items stocked or

monthly inputs (or variables positively correlated with them), the resulting correlation tends to be biased in a negative direction. In Table 3, significant correlations obtained under these conditions are all positive, so the unbiased correlation coefficients are actually larger (and thus more significant) than shown.

The time required for conversion (after adjustment for account size) is clearly related to position in the conversion schedule. The conversion reject rate is negatively related to conversion position; i.e., later conversions tend to have lower reject rates. Both of these effects imply that learning did occur. To some extent, the bases with larger accounts tend to have higher conversion rates.

It is interesting to note that there is no significant relationship between the four base characteristics variables and the postconversion fill-rate. Thus, we again find support for the widely held belief that fill-rate is a complex function (perhaps of weapons, maintenance policies, operational schedules, priorities, depot policies, and available funds) and should not be related in simple fashion to any of our variables. In particular, position in the conversion schedule (except perhaps at ATC) appears to have no significant effect on fill-rate.

The extent to which the base characteristics correlate with each other is shown in Table 4. As one might expect, items stocked and monthly inputs are significantly correlated. With the exception of TAC, rankings of mission difficulty are also significantly correlated with both items stocked and inputs. This difference between TAC and the other commands may be due to the manner of obtaining the .ssion difficulty rankings. At TAC, these rankings were based on a special study in which weights were assigned to type and variety of aircraft supported, frequency of deployment, special units supported, physical facilities affecting operation, and support from prime depot.* The bases were then rated separately on each variable, and the sum of the

*Management Analysis Section, Management and Programs Branch, Headquarters Tactical Air Command, <u>Mission Difficulty as it Affects Supply Performance.</u>

weighted variables for each base determined the relative rank on mission difficulty. Interviewees for the other three commands were requested to arrive at a composite ranking of mission difficulty, using essentially the same variables that TAC used. The high correlations between rankings of mission difficulty and account size seem to indicate that the raters regarded the two variables as roughly equivalent.

Table 4

CORRELATION BETWEEN BASE CHARACTERISTICS

Variable	ADC N=14	ATC N=14	SAC N=19	TAC N=14	Total N=61
Mission difficulty versus:					
Items stocked	0.92	0.80	0.81	0.06	0.75**
Average monthly inputs	0.84	0.67	0.76	0.22	0.67**
Position in conversion schedule	-0.34	-0.08	-0.20	0.00	-0.16
Items stocked versus:					
Average monthly inputs	0.96	0.77	0.82	0.78	0.86**
Position in conversion schedule	-0.32	-0.12	-0.16	-0.04	-0.16
Average monthly inputs versus:					
Position in conversion schedule	-0.35	0.32	-0.14	-0.16	-0.10

NOTE: ** = significant at the 0.01 confidence level.

RELATION BETWEEN PERFORMANCE VARIABLES AND PERSONNEL PROFICIENCY

This section describes the relationship between performance variables and rankings of base personnel proficiency. For this purpose, it is desirable to eliminate the effects of the base characteristics shown in Table 3 to prevent their obscuring the effects of major interest. This can be done statistically by using partial correlation coefficients. Since mission difficulty, items stocked, and monthly inputs are highly correlated, it is necessary only to hold one of these variables constant. Mission difficulty was selected for this purpose and is partialled out, or held constant, for all five performance variables. In addition, the effect of position in the conversion schedule is held constant for conversion time and conversion rejects.

Tables 5 through 9 present the correlation between five measures of base performance and eight rankings of base personnel proficiency.

As described above, the rankings were obtained from the conversion team members. Four of the rankings pertain specifically to the conversion effort and four are of a more general nature, although all of the team observations were confined to the conversion time period as opposed to the normal operation mode.

It may now be asked whether the conversion team's knowledge of base differences in the performance variables influenced the proficiency rankings. This may have had an effect with respect to the conversion time and conversion reject rate; however, it probably is not relevant for the postconversion performance measures. With the exception of those for SAC, the rankings were obtained during May 1965, and published supply performance summaries for the standard system were not available at that time. In particular, data on postconversion rejects were not included in the base monthly supply report, and were therefore not available at command headquarters, even in raw form.

The rankings pertaining to the conversion are as follows:

1. Preconversion file preparation. Extensive efforts on the part of base personnel were required to edit file records and convert them to the standard systems format.
2. Reconciliation of supply and accounting-finance records. The latter function was not automated prior to implementing the standard system, and its incorporation was considered one of the major preconversion tasks.
3. Training. Bases were ranked on the overall adequacy of all types of training directed a. prep- ing base personnel to convert to, and operate, the standard system.
4. EDP experience. Bases were ranked on t. skill level and number of individuals with EDP background. ATC bases were not ranked on this variable, since previous EDP experience was negligible.

Rankings of a more general nature are the following:

1. Morale and motivation. This was based largely on the degree of enthusiasm toward the new system and extent of involvement of base personnel with the conversion effort.
2. Location of management responsibility. This ranking was included in an attempt to examine the impact of close surveillance by top management (Chief of Supply), as opposed to instances when this responsibility resided at lower management levels.

3. Management discipline. This ranking expressed the extent to which personnel adhered to specified procedures and accomplished transactions "by the book."
4. Coordination among relevant groups. This was based on observations of coordination among supply, equipment, and accounting-finance groups.

In addition to rankings of personnel proficiency, Tables 5 through 8 provide the correlation between performance variables and four other factors:

1. Facilities. Conversion team members ranked bases in terms of adequacy of space and the degree of centralization of physical facilities.
2. Desirability of location. The variable was included on the supposition that the more desirable location might attract the more proficient personnel.
3. Actual/authorized manning. This was obtained from the conversion report (RCS: AF-E61) and refers to the total civilian and military manning.
4. Preconversion fill-rate. This is the average monthly base fill-rate for the approximate period, August 1965 to July 1966, and was obtained from command supply summaries (see Sec. 3). This variable is included to provide a comparison of pre- and postconversion performance.

Conversion Time

If the variables shown above influence the length of time required for base conversion, we would expect the correlation coefficients to be negative; that is, good file preparation, training, and the like, would be expected to produce shorter conversion times. (The data are presented in the Appendix in the form of partial correlations for the command samples, with mission difficulty and position in conversion schedule held constant.) For the total sample, ten of the twelve variables do correlate negatively, but no correlations are sufficiently large to be statistically significant. After accounting for computer downtime, account size, mission difficulty, and conversion position, the data show virtually no statistical relationship between measures of personnel proficiency and the time required to complete the conversion. These results should not be interpreted as meaning that factors such as preconversion file preparation are superfluous in determining

conversion time, but rather that, within the range of performance observed, they do not appear as limiting factors.

Conversion Reject Rate

Table 5 presents the correlation between the conversion reject rate and the same set of variables, with mission difficulty and conversion position held constant.

Table 5

CORRELATION BETWEEN CONVERSION REJECT RATE AND EXPLANATORY VARIABLES

Variable	ADC N=14	ATC N=13	SAC N=23	TAC N=14	Total N=64
File preparation	-0.64	-0.69	-0.20	-0.18	-0.42**
Reconciliation of supply and A & F files	-0.41	-0.29	-0.01	0.23	-0.11
Training	-0.60	0.00	-0.07	0.10	-0.14
EDP experience	-0.45	--	-0.55	0.36	-0.33*
Morale and motivation	-0.43	-0.47	0.03	-0.03	-0.19
Location of management responsibility	0.09	-0.38	-0.15	-0.28	-0.18
Management discipline	-0.34	-0.70	-0.24	-0.02	-0.34*
Coordination	0.12	-0.24	-0.19	-0.11	-0.13
Facilities	-0.06	-0.12	-0.12	0.10	-0.07
Desirability of location	-0.50	0.22	-0.25	0.07	-0.15
Actual/authorized manning	-0.19	-0.38	-0.30	0.25	-0.16
Preconversion fill-rate	0.10	0.67	0.68	-0.38	0.40**

NOTE: * = significant at the 0.05 confidence level.
** = significant at the 0.01 confidence level.

Again, we would expect the direction of correlation to be negative--i.e., high proficiency accompanied by low reject rates. In general, the coefficients are negative, although rather small. The correlations for ADC and ATC tend to be larger than those for SAC and TAC. It is likely that the observed conversion reject rate influenced the rankings for file preparation, reconciliation, and training at ADC and ATC bases, since these commands emphasized the importance of preconversion editing of files. On the other hand, both SAC and TAC depended more on conversion edits for this purpose.

For the total sample, ten of the twelve variables correlate negatively with conversion rejects, including all eight of the personnel proficiency variables. The relationships for file preparation, EDP experience, and management discipline are statistically significant. A somewhat surprising result is the significant positive correlation between conversion reject rate and the preconversion fill-rate. An explanation for this relationship is not apparent.

Postconversion Reject Rate

Table 6 presents the correlation between the postconversion reject rate and the explanatory variables, with mission difficulty held constant. We would expect the correlations to be negative, and the results largely bear this out. SAC and TAC are consistent in demonstrating moderately high negative correlations; the relation for ADC and ATC is more inconsistent. The correlations for the total sample are all negative, with management discipline, training, and file preparation showing the strongest relationships.

The right side of Table 6 shows the reject rates for three functions: item accounting, supply management, and "originator." These were derived from a larger classification of reject numbers, provided by Hq ADC and based primarily on the action point to which the reject notice is sent. The three categories account for about 90 percent of the total reject rate. The correlations between these and the explanatory variables are also uniformly negative, and several are substantially higher than those for the total reject rate. This indicates that we may expect reject rates derived from homogeneous sources to provide better measures of certain areas of personnel performance than overall rate does. For instance, item-accounting rejects correlate highest with management discipline and coordination; supply-management rejects with training and morale; and "originator" rejects with training.

Reverse-Post Rate

The correlations between postconversion reverse-post rates and the explanatory variables, with mission difficulty held constant, appear

Table 6

CORRELATION BETWEEN POSTCONVERSION REJECT RATE AND EXPLANATORY VARIABLES

Mission Difficulty Held Constant

Variable	Total Reject Rate					Reject Rate by Function		
	ADC N=14	ATC N=13	SAC N=19	TAC N=14	Total N=60	Item Account	Supply Mgmt	Origi-nator
File preparation	-0.07	-0.44	-0.44	-0.50	-0.38**	-0.24	-0.31*	-0.35*
Reconciliation of supply and A & F files	0.11	0.17	-0.27	-0.25	-0.10	-0.12	-0.11	-0.15
Training	-0.23	-0.21	-0.58	-0.50	-0.43**	-0.35*	-0.54**	-0.51**
EDP experience	0.57	--	-0.56	-0.47	-0.23	-0.11	-0.11	-0.30*
Morale and motivation	0.01	0.21	-0.54	-0.42	-0.27	-0.32*	-0.54**	-0.37**
Location of management responsibility	0.09	0.13	-0.53	-0.49	-0.28*	-0.35*	-0.34*	-0.32*
Management discipline	-0.17	-0.55	-0.49	-0.50	-0.44**	-0.58**	-0.32*	-0.34*
Coordination	-0.06	-0.02	-0.52	-0.42	-0.32*	-0.48**	-0.39*	-0.41**
Facilities	0.09	-0.20	-0.31	-0.44	-0.24	-0.35*	-0.14	-0.20
Desirability of location	0.16	-0.25	-0.36	-0.59	-0.29*	-0.24	-0.09	-0.21
Actual/authorized manning	0.31	0.00	0.00	-0.46	-0.04	-0.03	0.00	-0.08
Preconversion fill rate	-0.31	0.31	0.18	-0.73	-0.24	-0.25	-0.23	-0.21

NOTE: * = significant at the 0.05 confidence level.
** = significant at the 0.01 confidence level.

in the Appendix. The data are for ADC, SAC, and TAC--ATC did not record this measure during the period of study. In common with the reject rate, we expect negative correlations, and this is the case for 27 out of 36 of the command correlations. All of the correlations for the total sample are negative, but only those for training and morale-motivation show a significant relationship at the .05 confidence level. The relationship is strongest for TAC bases. In general, the reverse-post rate does not correlate with measures of proficiency as strongly as the reject rate does.

<u>Postconversion Fill-Rate</u>

Table 7 presents the correlations between the postconversion item fill-rate and the explanatory variables, with mission difficulty held constant. In this instance we would expect positive correlations--that is, high proficiency resulting in high performance as measured by the fill-rate. With a few exceptions, the correlations for the

Table 7

CORRELATION BETWEEN POSTCONVERSION FILL-RATE AND EXPLANATORY VARIABLES

Variable	ADC N=14	ATC N=9	SAC N=16	TAC N=14	Total N=53
File preparation	0.61	-0.33	0.12	0.53	0.33*
Reconciliation of supply and A & F files	0.58	-0.16	-0.09	0.15	0.17
Training	0.51	0.72	0.05	0.70	0.48**
EDP experience	0.35	--	-0.09	0.64	0.31
Morale and motivation	0.47	0.00	0.21	0.59	0.37*
Location of management responsibility	0.21	0.04	0.14	0.05	0.12
Management discipline	0.57	-0.15	0.37	0.66	0.45**
Coordination	0.43	0.27	-0.10	0.35	0.23
Facilities	0.09	0.29	-0.27	0.36	0.08
Desirability of location	0.19	-0.01	-0.14	0.70	0.24
Actual/authorized manning	-0.44	-0.84	0.65	0.15	0.00[a]
Preconversion fill-rate	0.58	0.55	-0.10	0.65	0.41**

NOTE: * = significant at the 0.05 confidence level.
** = significant at the 0.01 confidence level.

[a]The total correlation is suspect because of the extreme variation among the correlations for each command.

command samples are positive, and all of those for the total sample are in the expected direction. File preparation, training, morale and motivation, and management discipline are significantly related to the fill-rate. As expected, the preconversion fill-rate is positively correlated with the postconversion fill-rate, although this relationship is not strong.

CORRELATION AMONG PERFORMANCE VARIABLES

Table 8 shows the correlation among performance measures, with mission difficulty and conversion position held constant. Here, we are interested in whether a shorter-than-average conversion time or a low conversion reject rate is predictive of higher performance in the postconversion period, and whether the accuracy measures for file records and transactions are related to more direct measures of functions such as fill-rate.

Table 8

CORRELATION AMONG PERFORMANCE MEASURES[a]

Variable	ADC N=14	ATC N=13	SAC N=16	TAC N=14	Total N=57
Conversion time versus:					
Conversion reject rate	0.14	0.01	0.20	0.47	0.22
Postconversion reject rate	-0.03	0.14	0.34	0.28	0.20
Postconversion reverse post rate	0.24	--	-0.16	-0.05	-0.01
Postconversion fill-rate	0.55	0.24	0.13	0.11	0.27
Conversion reject rate versus:					
Postconversion reject rate	-0.06	0.61	0.32	0.06	0.25
Postconversion reverse post rate	0.07	--	-0.04	0.06	0.02
Postconversion fill-rate	-0.31	0.26	-0.46	0.04	-0.22
Postconversion reject rate versus:					
Postconversion reverse post rate	0.07	--	0.54	0.48	0.40*
Postconversion fill-rate	-0.17	-0.08	0.03	-0.44	-0.18
Postconversion reverse-post rate versus:					
Postconversion fill-rate	-0.21	--	0.36	-0.38	-0.05

NOTE: * = significant at the 0.05 confidence level.

[a]Mission difficulty and position in conversion schedule held constant.

The results show that the time required for conversion is unrelated to postconversion performance measures. The conversion reject rate tends to correlate with the postconversion reject rate and fill-rate in the expected directions, but the coefficients are small and insignificant. Similarly, the conversion reject rate does not significantly affect the conversion time. Postconversion reject and reverse-post rates are significantly correlated in a positive direction; however, neither measure shows a significant relationship with the postconversion fill-rate. In addition, neither measure correlates significantly with the preconversion fill-rate.

Lack of significant correlation among the postconversion performance measures raises the question of whether such measures actually quantify the success with which the organization fulfills its function. It seems reasonable to assume that the postconversion reject rate measures the proficiency with which personnel interact with the automated portion of the system, and that the frequency of file corrections indicates the degree of inconsistency between the records and the physical assets. We expect that these factors will eventually influence the fill-rate. For base supply organizations, the latter is most clearly related to function, i.e., the percentage of customer requests that are supplied. On the other hand, the fill-rate depends on a wide variety of variables, some of which are clearly beyond the influence of base personnel. In addition, many of the base actions that affect fill-rate are indirectly related to the automated system; e.g., anticipating requirements through coordination with base maintenance, setting of special levels, repairing parts (DIFM), and following up delays in receipts from the depots. In summary, the lack of a significant relation between the overall measure, fill-rate, and specific measures, such as reject rate, are probably due to the complex nature of the support system.

III. CONCLUDING REMARKS

Thus far, this Memorandum has presented an extensive array of definitions and numbers. While each reader will no doubt gain some insight from a perusal of the data, it might well be asked at this point what we gain from a quantitative study of this type. This section briefly addresses the question.

REVIEW OF RESULTS

At the end of the schedule, the conversion time for an average-size U.S. base was about two weeks--approximately 60 percent of the time required for the early conversions. Delays due to computer downtime showed a similar reduction as a function of position in the conversion schedule. Base personnel proficiency did not relate significantly to the conversion time, nor did the conversion reject rate. Within the range of performance observed, file preparation and other base personnel variables were not significant. Thus, the time required for the conversion, exclusive of computer downtime, was primarily a function of account size and position in the conversion schedule.

Postconversion reject and reverse-post rates are also related to base characteristics. The rates increase as a function of mission difficulty, items stocked, and monthly inputs, all of which are, in turn, strongly correlated in a positive direction. For commands such as ADC and ATC, where bases are quite heterogeneous with regard to account size, statistical adjustment for the account-size effect is necessary for meaningful interbase comparisons of reject and reverse-post rates.

Personnel proficiency ratings were significantly related to post-conversion performance measures. The postconversion reject rate was significantly lower for bases rated high in training, management discipline, and file preparation. When the total reject rate was subdivided by functions responsible for the error, several relationships were substantially increased, indicating that reject rates derived from homogeneous sources may provide good indicators for particular areas of personnel performance.

The reverse-post rate also was inversely correlated with ratings of personnel proficiency, although the relationships were weaker than those for the postconversion reject rate. The correlations of reverse-post rate with training and morale were statistically significant. The postconversion fill-rate and personnel proficiency were directly correlated, with training, morale, and management discipline showing the strongest relationships.

Intercommand comparisons are complicated by differences in weapons, bases, and operations; two observations are of possible interest, however. First, the postconversion error-reject rate and reverse-post rate are higher for SAC than for any other command (Appendix). SAC did not emphasize preconversion file preparation and training programs as strongly as the other commands--at least in terms of headquarters initiative and monitoring. Thus the data suggest that training and preparation do have an impact. Whether they are worth the cost remains an open question. Second, ATC recorded the lowest average postconversion error-reject rate, partly, at least, because reject rate tends to be related to account size. However, ATC is the command with the least preconversion EDP experience. Here the data indicate that conversion from a PCAM to computer operation of this nature presents no major problems. Interviews with ATC personnel confirmed this conclusion, except that lack of experienced console operators prolonged the time required for problem diagnosis.

IMPLEMENTATION

The data uniformly indicate that for such a package as the base supply system, a conversion is not as critical or as difficult as anticipated. Differences among commands and bases are not striking. Although learning reduces conversion times, the initial times are easily tolerated and the learning effect appears to occur rapidly. SAC, with minimum training and multiple implementation teams, incurred higher error rates, but no measurable degradation of fill-rate when compared with other commands.

This behavior suggests several areas for further thought and inquiry. Fill-rate appears insensitive to short-term changes in the supply system.

Base personnel apparently take steps to compensate for problems such as error-reject rates or, perhaps, difficulties caused by error-reject rates may not show up for a year or more. In this event, fill-rate looks like a very poor indicator of supply performance. On the other hand, the supply system (the prior ones and the new 1050 system) may simply have little effect on supply performance. If true, then one should reconsider any further development plans and try to find out what does determine supply performance.

Finally, our results strongly imply that the current study did not include many parts of the implementation process that are of major interest. We have learned from subsequent experience that Commands did have different troubles. Certain aspects of the system--for example, DIFM control--needed substantial overhaul. This experience suggests that the Air Force should look in much more detail at any subsequent implementation of this type.

Appendix

DATA USED IN THE IMPLEMENTATION STUDY

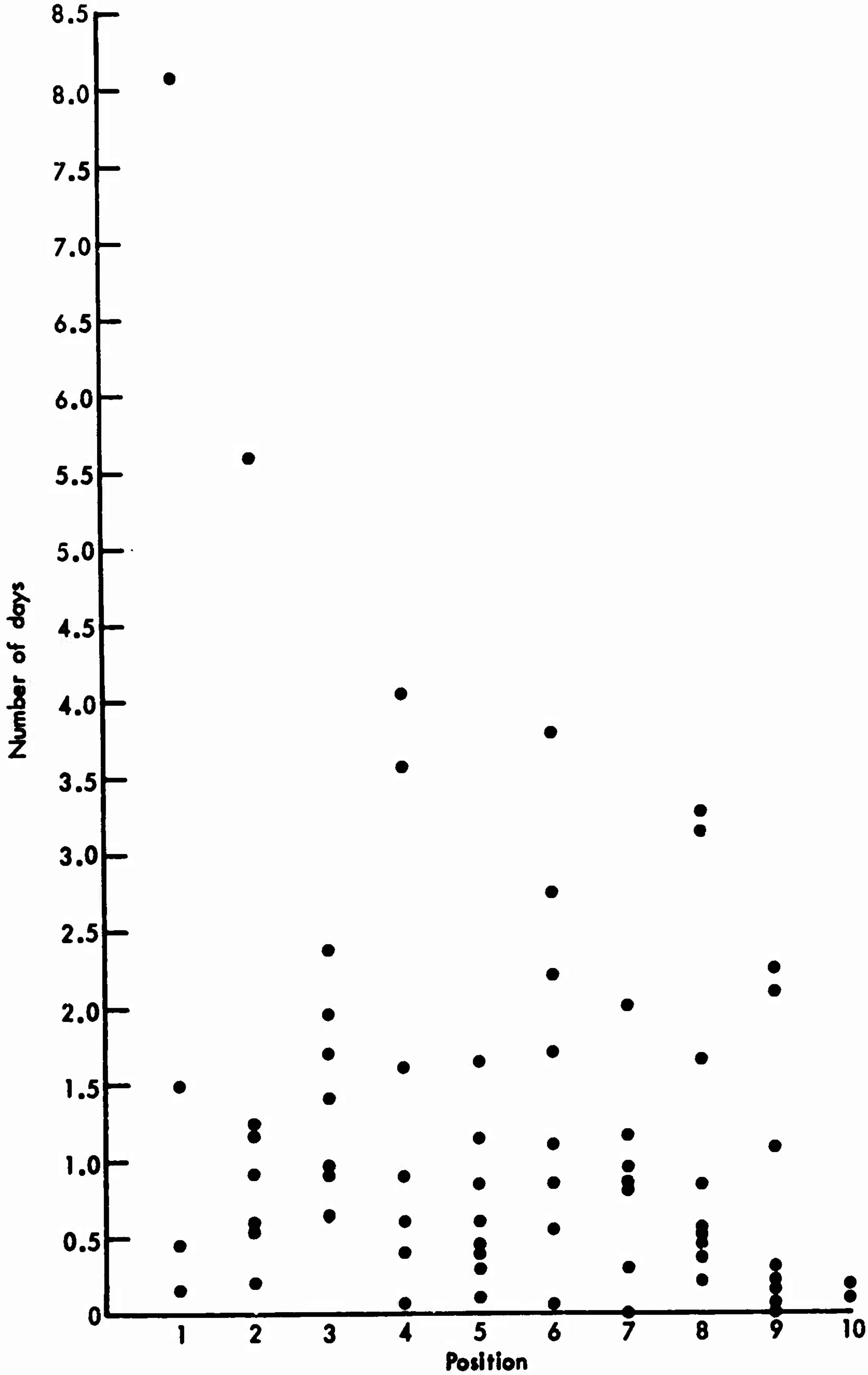

Fig. 3 -- Computer downtime as a function of position in conversion schedule; ADC, ATC, SAC, and TAC

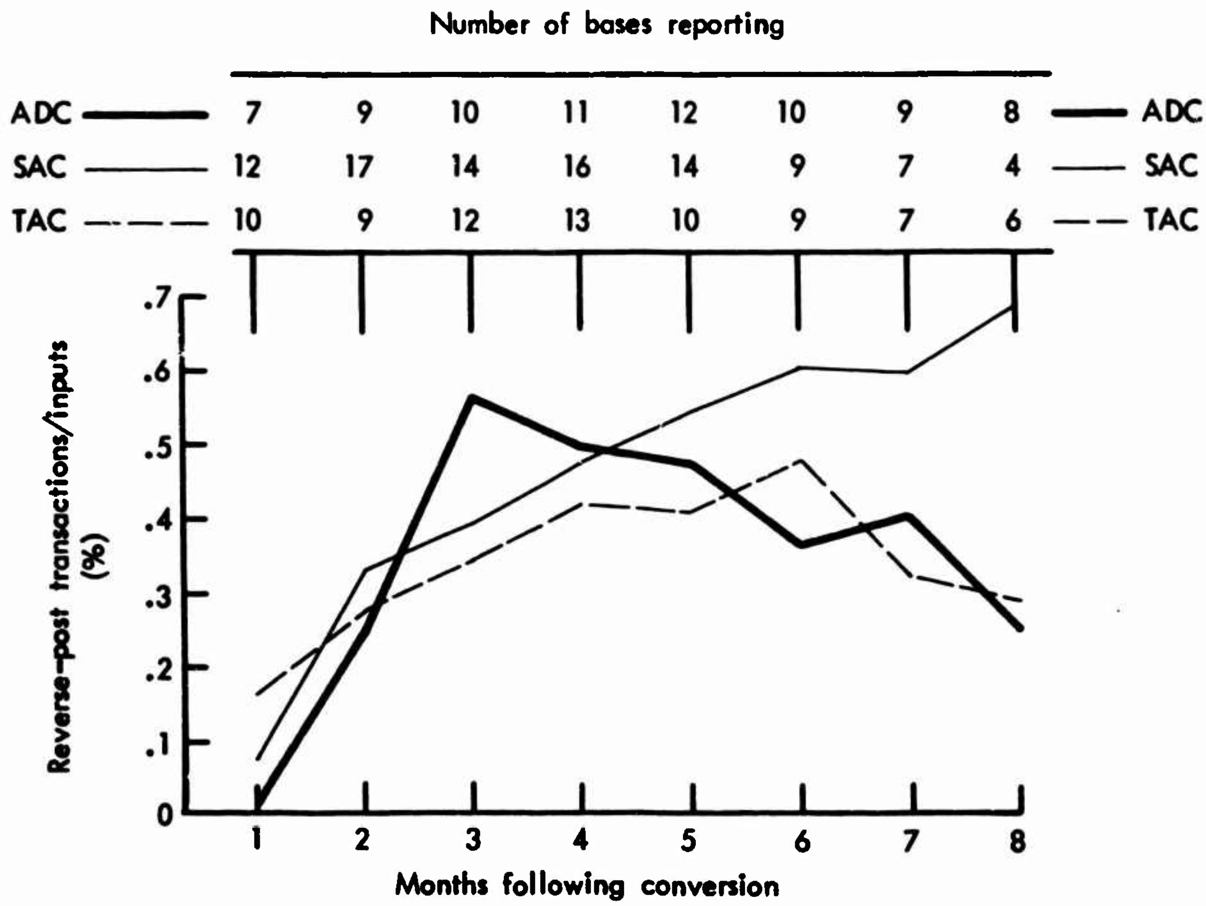

Fig. 4 -- Mean postconversion reverse-post rate as a function of number of months following conversion

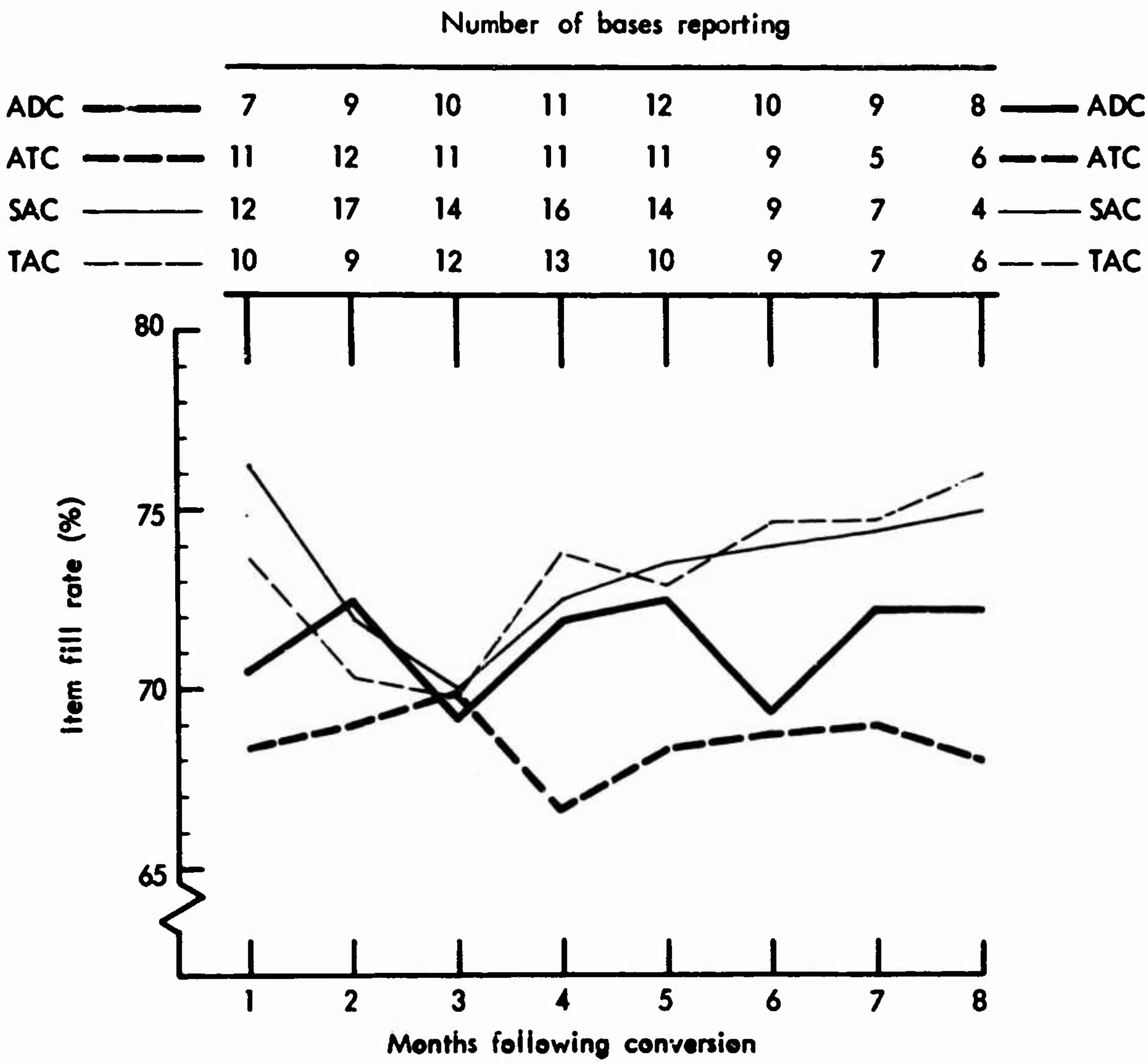

Fig. 5 -- Mean postconversion item fill-rate as a function of number of months following conversion

Table 9

NUMBER OF ITEMS STOCKED AT COMMAND BASES

Command	Items Stocked (thousands) and Number of Bases								
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100
ADC		4	2	1	1	2	1	2	1
ATC	3	4	3		3	1			
SAC			1	6	3	6	3		
TAC		2	1	5	3	2	1		

Table 10

CORRELATION BETWEEN CONVERSION TIME AND EXPLANATORY VARIABLES

Mission Difficulty and Position in Conversion Schedule Held Constant

Variable	ADC N=14	ATC[a] N=14	SAC N=23	TAC N=14	Total N=65
File preparation	0.18	-0.37	-0.41	0.31	-0.23
Reconciliation of supply and A & F files	0.15	-0.53	-0.47	-0.08	-0.25
Training	0.14	-0.17	-0.29	0.16	-0.09
EDP experience	0.11	--	-0.14	0.17	-0.01
Morale and motivation	0.31	0.24	-0.32	0.15	0.01
Location of management responsibility	-0.15	0.48	-0.26	0.15	-0.05
Management discipline	0.60	0.09	-0.35	-0.01	0.05
Coordination	-0.03	0.05	-0.37	0.18	-0.17
Facilities	-0.18	-0.24	0.11	-0.05	-0.06
Desirability of location	0.31	0.03	-0.23	-0.11	-0.01
Actual/authorized manning	0.02	0.22	-0.21	0.01	-0.04
Preconversion fill-rate	0.10	-0.51	0.14	-0.31	-0.06

[a]ATC conversion time is for steps 3 through 5.

Table 11

CORRELATION BETWEEN POSTCONVERSION REVERSE-POST RATE AND EXPLANATORY VARIABLES

Mission Difficulty Held Constant

Variable	ADC N=14	SAC N=18	TAC N=14	Total N=46
File preparation	-0.17	0.17	-0.59	-0.18
Reconciliation of supply and A & F files	-0.28	-0.14	-0.30	-0.23
Training	-0.22	-0.20	-0.62	-0.34*
EDP experience	0.12	-0.28	-0.64	-0.30
Morale and motivation	-0.20	-0.08	-0.64	-0.31*
Location of management responsibility	0.27	-0.11	-0.78	-0.26
Management discipline	0.03	0.01	-0.68	-0.23
Coordination	0.05	-0.23	-0.58	-0.27
Facilities	-0.39	0.08	-0.21	-0.15
Desirability of location	-0.01	0.13	-0.46	-0.10
Actual/authorized manning	0.01	-0.05	-0.08	-0.04
Preconversion fill rate	-0.27	-0.01	-0.39	-0.21

*Significant at the 0.05 confidence level.

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10. ABSTRACT

A quantitative analysis of the installation and subsequent operation of the USAF Standard Base Level Supply System. In 1965-1966, 110 bases were converted to the Standard System, which was intended to provide standardized computers (UNIVAC 1050-II), programs, and external procedures for base supply operations throughout the Air Force. The data used in the study came from 103 bases, 69 belonging to ADC, ATC, SAC, and TAC. The analysis shows that conversion to the new system was easier than expected. The time required was related to the size of the operation and the date of conversion: By the end of the program, conversion time averaged 2 weeks, 40 percent less than at the beginning. Learning appears to have progressed rapidly. The error rate (input error and record inconsistencies) increased with the amount of activity: The larger the base, the higher rate of the errors. SAC, with minimal training, had higher error rates for one month, but fill rate (percentage of item requests filled) did not suffer measurably during the first year. Average fill rate did not show changes as a result of changing the system, although the month-to-month fluctuations were greater, suggesting that perhaps a better performance measure than fill rate is needed.

11. KEY WORDS

Air Force
Bases
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